भारतीय मानक
Indian Standard

IS 15680 : 2021

स्टीम ट्रैप के चयन की मार्गदर्शिका

(पहला पुनरीक्षण)

Guidelines for Selection of Steam Traps

(First Revision)

ICS 27.010

© BIS 2021

भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुरशाह ज़फर मार्ग, नई दिल्ली – 110002
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI-110002
www.bis.gov.in www.standardsbis.in

November 2021 **Price Group 6**

Boilers and Pressure Vessels Sectional Committee MED 01

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Boilers and Pressure Vessels Sectional Committee had been approved by the Mechanical Engineering Divisional Council.

This standard has been updated based on the experience of manufacturer and the user organization, prevalent design and operation of steam traps. More types of steam traps like liquid expansion traps, piston traps and lever traps, sizing methodology have been added with updation of typical chart for steam trap selection and applications.

The composition of the committee responsible for the formulation of this standard is given in Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (*revised*)’. The number of significant places retained in the rounded off values should be the same as that of the specified value in the standard.

Indian Standard

GUIDELINES FOR SELECTION OF STEAM TRAPS

(First Revision)

1 SCOPE

This standard covers principle of operation and guidelines for selection of various types of steam traps.

2 VARIOUS TYPES OF STEAM TRAPS

2.1 Mechanical or Density Operated Traps

2.1.1 *Ball Float with Thermostatic Air Vents*

2.1.1.1 *Operation*

Air entering the trap is immediately discharged through a high capacity thermostatic auxiliary air vent. Condensate causes the ball float to rise and place the modulating discharge valve in a position that will pass the condensate continuously as it enters the trap. The condensate is released through the valve by steam pressure. The condensate level in the trap body is maintained above the discharge valve to provide a positive seal against the loss of steam. Refer Fig. 1 for float and thermostatic steam trap.

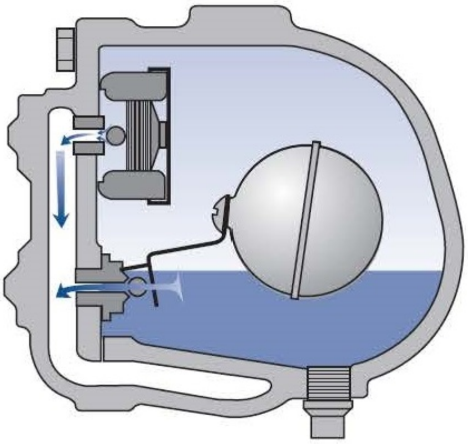

FIG. 1 FLOAT AND THERMOSTATIC STEAM TRAP

2.1.1.2 *Special features*

a) Discharge condensate continuously as rapidly as it forms;
b) High air venting capacity through thermostatic auxiliary balanced pressure air vent, which is self adjusting for varying steam pressures;
c) High thermal efficiency at both light and heavy loads;
d) Continuous modulating discharge does not create pressure disturbances, which may cause erratic control in air heating coils, shell and tube exchangers, etc;
e) Steam lock release (S.L.R.) facility available;
f) In line inlet and outlet facility, easy installation at low cost;
g) Robust, fair resistance to water hammer;
h) Fails in closed position, so no wastage of steam energy;
j) Unaffected by changes in inlet pressure;
k) Suitable for high condensate loads;
m) Available with screwed / socket welded / flanged end connection; and
n) Available with in-built/separate strainers.

2.1.1.3 *Typical applications*

Air unit heaters, hot water heaters, heat exchangers, fuel oil heaters, converters, dryers, re-boilers, jacketed pans and process equipment.

2.1.1.4 *Limitations*

a) Cannot be used where trap is fitted with air vent and degree of superheat is more than 100°C,
b) Water hammer can damage float,
c) Suitable only for relatively low pressure,
d) Does not withstand freezing and requires insulation in cold climate, and
e) Not self draining.

2.1.2 *Inverted Bucket Traps*

2.1.2.1 *Operation*

The trap body is normally filled with condensate to maintain a seal around the inverted bucket, which serves as a float to operate the discharge valve. Live steam entering the bucket floats it to close the valve. During the closed period, condensate collects in the piping at the inlet side of the valve until steam floating the bucket leaks through a small hole in the top of the bucket and permits the bucket to drop and open the valve. The condensate is discharged, followed by steam, which is required to actuate the float mechanism. Air can pass through the small hole at the top of the bucket. Refer Fig. 2 for inverted bucket trap.

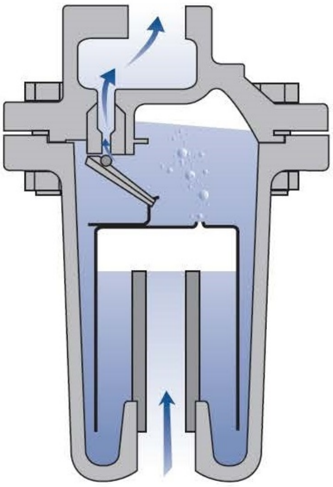

FIG. 2 INVERTED BUCKET TRAP

2.1.2.2 *Special features*

a) Good resistance to water hammer,
b) Simple and robust mechanism and easy to maintain,
c) Intermittent discharge,
d) Discharge condensate and air at steam temperature,
e) Operate on superheated steam,
f) Operate against any back pressure,
g) Available with in-built/separate strainers,
h) Available with screwed/socket welded/flanged end connection, and
j) Operate at high pressures.

2.1.2.3 *Typical applications*

High pressure indoor steam main drips and submerged heating coils, kettles.

2.1.2.4 *Limitations*

a) Low thermal efficiency under varying loads and pressures and some steam loss for operation,
b) Must maintain water seal to avoid continuous discharge of steam,
c) Must be protected from freezing,
d) Discharge condensate continuously as rapidly as it forms, and
e) Bleed hole in bucket has very limited air-venting capacity.

2.2 Temperature Operated Traps

2.2.1 *Balanced Pressure Thermostatic Traps*

2.2.1.1 *Operation*

The trap is operated by a flexible thermostatic element filled with a fluid (the valve actuator is a capsule or bellow filled with a fluid), which when heated or cooled evaporates or condenses. Internal pressure changes expand or contract the element and position the attached valve head. On start-up the cold elements is contracted, and the wide open valve remains open to discharge air and sub-cools condensate. When steam reaches the trap, the element expands and closes the trap. When condensate surrounding the capsule cools to approximately 10 °C to 20 °C below steam temperature (depending on the filling) the trap opens to discharge condensate. Refer Fig. 3 for balanced pressure thermostatic steam trap.

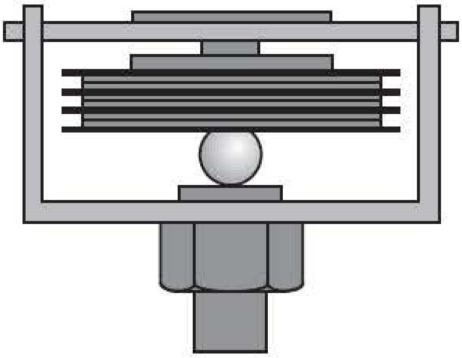

FIG. 3 BALANCED PRESSURE THERMOSTATIC TRAPS

2.2.1.2 *Special features*

a) High air venting capacity for fast start-up,
b) Large capacity in small size,
c) Self adjusting – will operate without adjustments at all pressures within its range,
d) Will not freeze if given free discharge,
e) Use same valve sizes for all pressures within its operating range,
f) Minimum parts,
g) Operates in vacuum systems,
h) Modulating discharge,
j) Operate on moderate superheated steam,
k) Discharges condensate close to steam temperature (5-10 °C sub-cooling),
m) Reacts to temperature changes immediately,
n) Ensure prevention of live steam loss,
p) Available with in-built strainers, and
q) Available with screwed/socket welded/flanged end connections.

2.2.1.3 *Typical applications*

Steam radiators, low and medium pressure submerged heating coil, sterilizers, steam tracer, steam mains, presses and dryers.

2.2.1.4 *Limitations*

Not suitable for highly superheated steam,

Limited resistance to water hammer and corrosion, and

Not suitable for applications in which condensate must be discharged as fast as it is formed.

2.2.2 *Bi-metallic Thermostatic Trap*

2.2.2.1 *Operation*

The operating principle is based on a balance between the steam force (pressure dependent), trying to open the discharge valve, and the opposing bi-metal force (temperature dependent) which tends to close it. The trap is adjusted so that all saturated steam temperature the bi-metallic force will prevail, while with under-cooled condensate and air, the force of pressure will prevail and open the valve trap, the required under-cooling should be minimum possible throughout the designed pressure range. Being the steam force a curve while the bimetallic force a straight line, an additional compensating spring will break the straight line to make it follow the curve of steam more closely making field adjustment unnecessary. Refer Fig. 4 for Bi-metallic thermostatic steam trap.

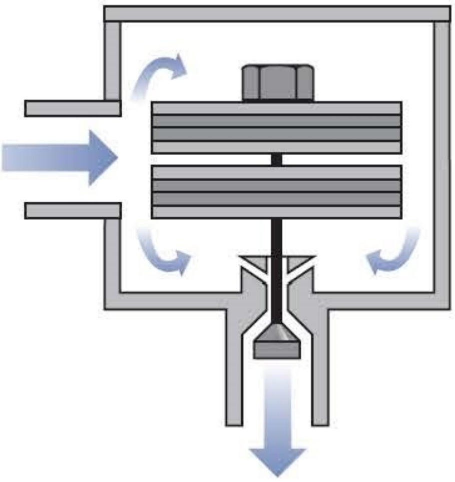

FIG. 4 BI-METALLIC THERMOSTATIC TRAP

2.2.2.2 *Special features*

a) Modulating discharge,

b) Condensate is discharged below steam temperature (20 °C/30 °C). Sub-cooling temperature can be adjusted on field,

c) A compensating spring between the bi-metallic element and the valve steam ensures that the trap operation follows the steam curve closely. The spring does not induce valve spring,

d) May be used on superheated steam,

e) Valve steam acts as a checked valve,

f) Resist water hammer and vibration,

g) Replaceable internal parts,

h) Efficient discharge of air and non-condensable gases,

j) Freeze proof full size 'Y' pattern integral strainer, and

k) Capability to mount in different orientations.

2.2.2.3 *Typical applications*

Tracing lines, tank heaters, marine applications.

2.2.2.4 *Limitations*

a) Relatively slow response to changing condensate loads, and

b) Susceptibility of bi-metallic elements to corrosion.

2.2.3 *Liquid Expansion Traps*

2.2.3.1 *Operation*

The trap consists of chamber filled with a liquid which actuates a piston connected to a valve. Air and condensate are discharged on start-up until the condensate reaches a predetermined temperature. At this point, the expanding liquid pushes the piston and thus throttles the valve to maintain a preset condensate discharge temperature. When the condensate cools, the liquid contracts and the piston is pushed back by a spring. Refer Fig. 5 for liquid expansion trap.

2.2.3.2 *Special features*

a) Resist water hammer,

b) Good thermal efficiency, and

c) Minimize flash steam due to low temperature discharge.

2.2.3.3 *Typical applications*

Tracing lines, storage tanks.

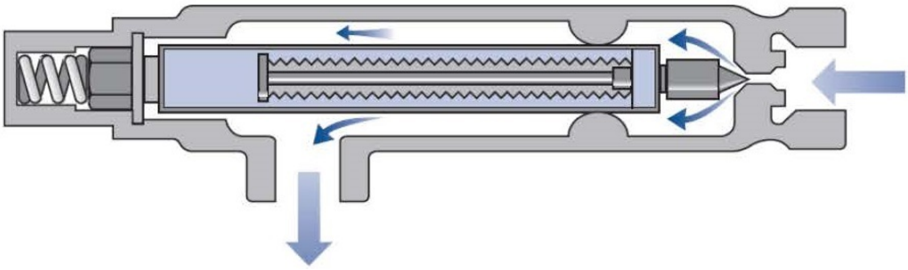

FIG. 5 LIQUID EXPANSION TRAP

2.2.3.4 *Limitations*

Inability to adjust to pressure changes.

2.3 Kinetic Energy Operated Traps

2.3.1 *Thermodynamic Disc Traps*

2.3.1.1 *Operation*

Condensate and air raise the disc and flow freely through the trap. When steam reaches the trap, the velocity under the disc is instantly increased and recompression above the disc snaps it on to its seats to give a tight shut off. Heat loss from the small control chamber, which is filled with a steam, condensate mixture, causes the chamber pressure to decrease to a point at which the valve disc opens again to discharge condensate. Refer Fig. 6 for thermodynamic disc trap.

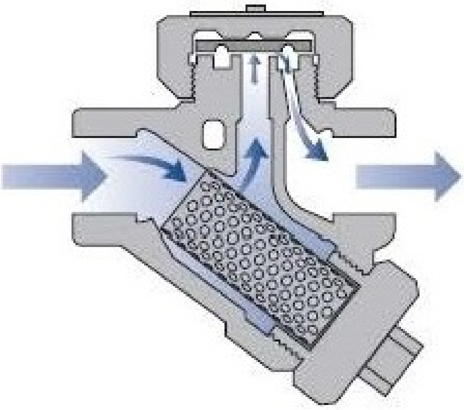

FIG. 6 THERMODYNAMIC DISC TRAP

2.3.1.2 *Special features*

a) Compact and light weight;
b) High resistance to water hammer;
c) Long life due to hardened seat and disc;
d) Only one moving part;
e) Efficient operation under varying loads and pressures;
f) Fast response to changing loads;
g) Discharges condensate at steam temperature, prevent water logging;
h) Discharges air and non-condensable gases;
j) Freeze proof
k) Operates on superheated steam;
m) Available with in-built strainers; and
n) Available with screwed/socket welded/butt welded/flanged end connection.

2.3.1.3 *Typical applications*

Steam main drips, high pressure and superheat, steam tracer lines, unit heaters.

2.3.1.4 *Limitations*

a) Not suitable for pressures below 0.25 bar(g), and
b) Some models limited 50 percent back pressures, others suitable for 80 percent of back pressures.

2.3.2 *Piston Traps*

2.3.2.1 *Operation*

This trap operate on the same principle as disc traps, utilizing the hot condensate heat energy and the kinetic energy of steam to actuate a piston to open and close the discharge path. The primary difference between the piston and disc trap is that the piston is hollow which creates two orifices (the hollow piston and the valve body) for the fluid to flow through. The hollow piston or alternatively called the control orifice provides a continuous discharge path for air and other non-condensable gases to pass through. Refer Fig. 7 for piston trap.

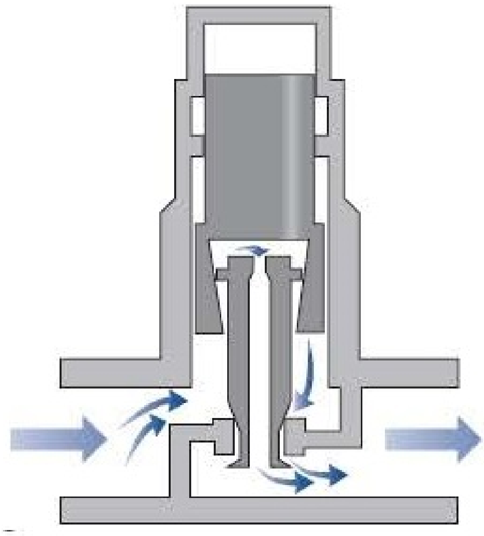

FIG. 7 PISTON TRAP

2.3.2.2 *Special features*

a) Operates at high pressures,
b) Capability to mount in different orientations,
c) Good response to changing condensate load conditions,
d) Rugged, withstands water hammer,
e) Self-draining, not damaged by freezing,
f) Function not impaired by superheat,
g) Good air handling capability,
h) Primary failure mode-open, and
j) Small size and light weight.

2.3.2.3 *Typical applications*

Heat exchangers.

2.3.2.4 *Limitations*

a) Excessive backpressure in return systems can prevent trap from closing,

b) Condensate discharge temperature follows the saturation curve over a limited range, and

c) Difficult to field check because of continuous control flow discharge.

2.3.3 *Lever Traps*

2.3.3.1 *Operation*

Lever traps are a variation of piston traps utilizing lever action in conjunction with control orifices. When the lever is closed there is limited flow through the valve body and the control orifice. Condensate pushes the lever upwards with a tilting motion and flows underneath it and out through the discharge port. When condensate is close to the temperature of steam, the restriction in the lever body causes it to be re-seated due to the condensate flashing into steam above the lever body.

2.3.3.2 *Special features*

a) Capable of handling large condensate loads,

b) Very rapid discharge of condensate after its formation,

c) Suitable for high pressure applications,

d) Rugged, withstands water hammer,

e) Not damaged by freezing,

f) Function not impaired by superheat,

g) Good air handling capability, and

h) Small, compact, easy to install and service.

2.3.3.3 *Typical applications*

Rotating drying cylinders.

2.3.3.4 *Limitations*

a) Excessive back pressure in return systems can prevent trap from closing,

b) Difficult to field check due to continuous control flow discharge, and

c) Can only be mounted in one position.

3 TYPICAL CHART FOR STEAM TRAP SELECTION AND APPLICATIONS

Sl No.	Application of Traps	1st Choice						2nd Choice						Safety Factor
		Float and Thermostatic	Thermo-dynamic	Balanced Pressure	Bimetallic	Liquid Expansion	Inverted Bucket	Float and Thermostatic	Thermo-dynamic	Balanced Pressure	Bimetallic	Liquid Expansion	Inverted Bucket	
A	**Steam Mains**													**2.0**
1	Low pressure < 1 bar(g)	√											√	
2	Medium pressure 1 to 120 bar(g)		√										√	
3	High pressure > 120 bar(g)		√										√	
4	With superheat		√								√			
B	**Steam Separators**													**3.0**
1	Pressure < 1 bar(g)	√											√	
2	Pressure > 1 bar(g)		√										√	
C	**Steam Tracers**													**2.0**
1	Critical		√							√				
2	Non-critical			√					√					
D	**Heating Equipment**													**2.0**
1	Shell and tube heat exchanger	√											√	
2	Blenders	√											√	
3	Heating coils	√											√	
4	Unit heaters	√											√	
5	Suction heaters	√											√	
6	Plate and frame heat exchangers	√											√	
7	Drying rooms	√											√	
8	Submerged coils	√											√	
9	Water heaters	√											√	
10	Radiators			√										

Sl No.	Application of Traps	1^{st}Choice							2^{nd} Choice					Safety Factor
		Float and Thermostatic	Thermo-dynamic	Balanced Pressure	Bimetallic	Liquid Expansion	Inverted Bucket	Float and Thermostatic	Thermo-dynamic	Balanced Pressure	Bimetallic	Liquid Expansion	Inverted Bucket	
E	**General Process Equipment**													**3.0**
1	Low pressure < 1 bar(g)	√											√	
2	Medium pressure 1 to 120 bar(g)	√											√	
3	High pressure > 120 bar(g)						√							
F	**Fuel Oil Heating**													**1.25**
1	Bulk storage tanks				√					√				
2	Line heaters	√											√	
G	**Tanks and Vats**													**3.0**
1	Bulk storage tanks				√					√				
2	Asphalt tanks				√					√				
3	Plating tanks				√					√				
4	Dye vats				√					√				
5	Evaporators				√					√				
H	**Vulcanizers**		√					√						**2.0**
I	**Freeze Protection**					√								**3.0**
J	**Pans**													**3.0**
1	Sugar dryers	√											√	
2	Jacketed Pans	√											√	
3	Tilting kettles	√											√	
4	Brew kettles	√											√	
5	Candy kettles	√											√	
6	Cheese kettles	√											√	
K	**Drying Cylinders**													**5.0**
1	Paper dryers	√											√	
2	Pulp dryers	√											√	
3	Rotary dryers	√											√	
4	Calendars	√											√	

Sl No.	Application of Traps	1st Choice							2nd Choice					Safety Factor
		Float and Thermostatic	Thermo-dynamic	Balanced Pressure	Bimetallic	Liquid Expansion	Inverted Bucket	Float and Thermostatic	Thermo-dynamic	Balanced Pressure	Bimetallic	Liquid Expansion	Inverted Bucket	
L	**Presses**													**5.0**
1	Plywood presses		√							√				
2	Moulding presses		√							√				
3	Tire mould presses		√							√				
4	Vulcanizing presses		√							√				
5	Milk dryers		√							√				
M	**Ovens**													**5.0**
1	Dressing sterilizers	√								√				
2	Pressure cookers	√								√				
3	Autoclaves	√								√				
4	Drum dryers	√								√				
N	**Ironing Machines**						√		√					**3.0**
O	**Turbines**		√										√	**2.0**
P	**Marine Applications**		√								√			**2.0**

4 SIZING METHODOLOGY

In order to properly size a steam trap, several design parameters must be taken into considerations. The following should be known:

a) Differential pressure,
b) Orifice/seat size, and
c) Condensate temperature.

4.1 Calculating Condensate Loads

4.1.1 *Warm-up Condensate Load*

$$C_W = \frac{0.114\, W_p \left(T_2 - T_1\right)}{H_l t_{(1 \to 2)}}$$

where

C_w = *warm-up condensate load* (*kg/h*);
W_p = *weight of pipe* (*kg*);
T_2 = *Final temperature at time*$_2$ (℃);
H_i = *Latent heat of steam* (*kcal/kg*); *and*
$(1 \rightarrow 2)$ = *Time difference from time* t_1 *to time* t_2 (*h*).

4.1.2 *Continuous Condensate Load*

$$C_R = \frac{\mathrm{U\,A}\left(T_s - T_a\right)}{H_l}$$

C_R = *Continuous condensate load*;
U = *Overall heat transfer coefficient* (*kcal/m*^{2} – *h* – ℃);
A = *External Pipe/insulation area* (*m*^{2});
T_s = *Steam temperature* (℃); and
T_a = *Air temperature* (℃) H_1 = *Latent heat of steam* (*kcal/kg*).

4.1.3 Total condensate load for trap sizing (kg/h) = Condensate load × Safety Factor (as per **3**).

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Boilers and Pressure Vessels Sectional Committee, MED 01

Organization	*Representative (s)*
Ministry of Commerce and Industry, Department for Promotion of Industry and Internal Trade, New Delhi	Shri T. S. G. Narayannen (***Chairman***)
Bharat Heavy Electrical Limited, New Delhi	Shri A. K. Shunmugam Shri R. K. Chandra (*Alternate* I) Shri Kishore Kumar K. (*Alternate* II) Shri Bhargav T. S. N (*Alternate* III) Shri G. Vimalan (*Alternate* IV) Shri Rudrabhatla Sai Kumar (*Alternate* V)
Bharat Petroleum Corporation Limited, Mumbai	Shri K. Rajashekar Shri Sathyan V. (*Alternate*)
Bureau Veritas India Private Limited, Noida	Shri Ranjit D. Naik Shri T. T. Subramanian (*Alternate*)
CSIR-Central Mechanical Engineering Research Institute, Durgapur	Shri Atanu Saha Shri Kamal Kishor J. Uke (*Alternate*)
Central Electricity Authority, New Delhi	Shri Prabhjot Singh Sahi Shri Jugal Kishor (*Alternate*)
Directorate General Factory Advice Service and Labour Institutes, Mumbai	Shri Sumit Roy Shri Kunal Sharma (*Alternate*) Shri H. M. Bhandari (*Alternate*)
Engineers India Limited, New Delhi	Shri Tarun Kumar Shri P. V. S. Satyanarayana (*Alternate*)
GE Power India Limited (Alstom Project India Limited), Noida	Shri G. Gopinath Shri M. Anandhan (*Alternate*)
Godrej & Boyce Manufacturing Company Limited, Mumbai	Shri Vasudev P. Shenoy Shri Jayvant Pingale (*Alternate*)
Hindustan Petroleum Corporation Limited, Mumbai	Shri Y. Sriramulu Shri Mutnury Somasuner (*Alternate*)
India Sugar and General Engineering Corporation, Noida	Shri J. Rajavel Shri M. Ganeswara Rao (*Alternate*)
Indian Boilers Manufacturers Association, Mumbai	Shri Kishor Tapaswi
Indian Oil Corporation Limited, New Delhi	Shri U. S. Prasad Shri R. K. Sabharwal (*Alternate*)
Indian Register of Shipping, Mumbai	Shri R. Ravi Shri Pradeep Bansal (*Alternate*)
Indra Gandhi Centre for Atomic Research, Kalpakkam	Shri B. K. Sreedhar Shri V. Vinod (*Alternate*)
Industrial Boilers Limited, Nehru Place, New Delhi	Shri Cyrus R. Engineer Shri R. R. Engineer (*Alternate*)
L & T Sargent & Lundy Limited, Vadodara	Shri Yogendra D Mishra Shri Karthik T. (*Alternate*)

Organization	*Representative (s)*
Larsen and Toubro Limited, Mumbai	Shri Girish Y. Savant Shri M. Venkatesh (*Alternate*)
Lloyd Register Asia, Mumbai	Shri P. Brahma Shri G. S. Saini (YP) Shri Puran Chand Pathak (*Alternate*)
MECON Limited, Ranchi	Shri Gurnek Singh Shri Abhay Kumar (*Alternate*)
NTPC Limited, New Delhi	Shri D. K. Dubey Shri G. Venu (*Alternate*)
Oil Industry Safety Directorate, Noida	Shri S. C. Gupta Shri S. K. Sharma (*Alternate*)
Petroleum and Explosives Safety Organisation, Nagpur	Shri D. K. Gupta Shri V. B. Borgaonkar (*Alternate*)
Project and Development India Limited, Noida	Shri Y. K. Gautam Shri Rajeev Ranjan Kumar (*Alternate*)
Reliance India Limited, Mumbai	Shri Sanjiv Prasad
Tata Steel Limited, Kolkata	Shri Braj B. Prasad Shri Pradip Chakraborty (*Alternate*)
Tema India Limited, Mumbai	Shri Haresh K. Sippy Shri Chetan S. Doshi (*Alternate*)
Thermax Babcock Wilcox Energy Solutions Private Limited, Mumbai	Shri S. A. Vanchinath Shri Ajay Hantodkar (*Alternate*)
Thermax Limited, Pune	Shri Nirav Shah (YP)
Welding Research Institute, Tiruchirappalli	Shri N. Raju Shri B. Shanmugarajan (*Alternate*)
BIS Directorate General	Shri A. Rajneesh Khosla Scientist 'E' and 'H' Head (MED) [Representing Director General (*Ex-officio*)]

Member Secretary

Shrimati Khashboo Kumari
Scientist 'C' (MED), BIS

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 2016 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

BIS has the copyright of all its publications. No part of these publications may be reproduced in any form without the prior permission in writing of BIS. This does not preclude the free use, in the course of implementing the standard, of necessary details, such as symbols and sizes, type or grade designations. Enquiries relating to copyright be addressed to the Director (Publications), BIS.

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

This Indian Standard has been developed from Doc No.: MED 01 (16989).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402 *Website*: www.bis.gov.in

Regional Offices:		*Telephones*
Central	: Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110002	2323 7617 2323 3841
Eastern	: 1/14 C.I.T. Scheme VII M, V.I.P. Road, Kankurgachi KOLKATA 700054	2337 8499, 2337 8561 2337 8626, 2337 9120
Northern	: Plot No. 4-A, Sector 27-B, Madhya Marg CHANDIGARH 160019	265 0206 265 0290
Southern	: C.I.T. Campus, IV Cross Road, CHENNAI 600113	2254 1216, 2254 1442 2254 2519, 2254 2315
Western	: Manakalaya, E9 MIDC, Marol, Andheri (East) MUMBAI 400093	2832 9295, 2832 7858 2832 7891, 2832 7892

Branches : AHMEDABAD. BENGALURU. BHOPAL. BHUBANESHWAR. COIMBATORE. DEHRADUN. DURGAPUR. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. JAMMU. JAMSHEDPUR. KOCHI. LUCKNOW. NAGPUR. PARWANOO. PATNA. PUNE. RAIPUR. RAJKOT. VISAKHAPATNAM.

Published by BIS, New Delhi